TECHNOLOGY DEPT.

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Principal Contents :

WORKS ORGANISATION FOR RESEARCH AND DEVELOPMENT OF AIRCRAFT ENGINES
By J. S. Paget, B.A.,(Cantab.), A.M.I.Mech.E., M.I.Prod.E.

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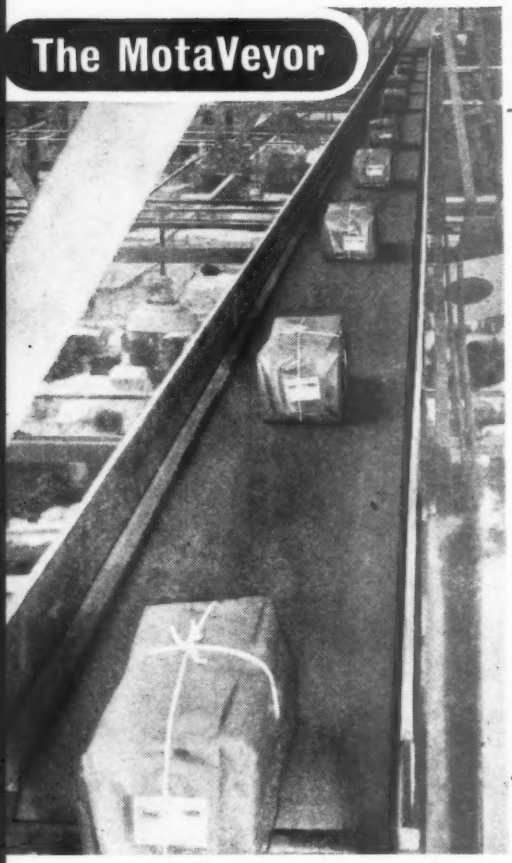

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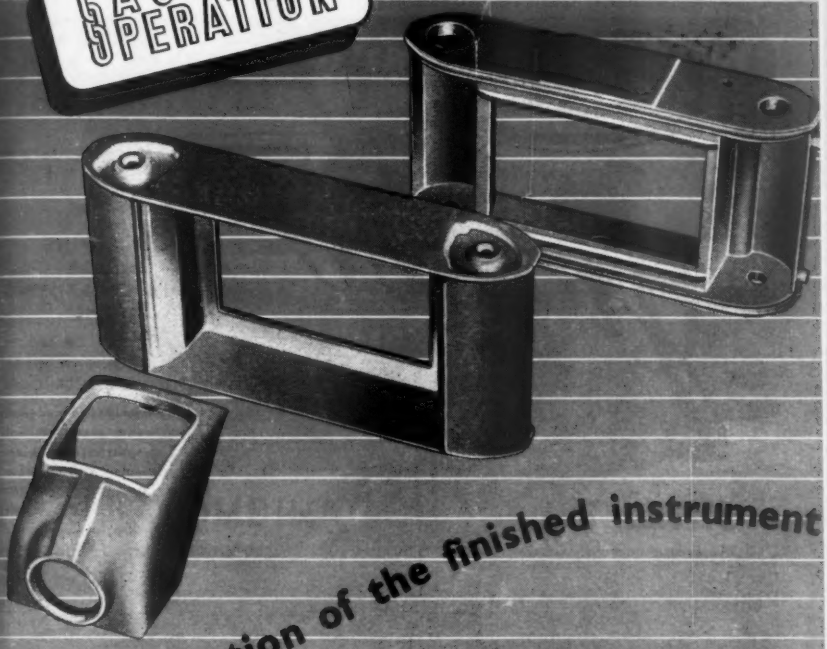

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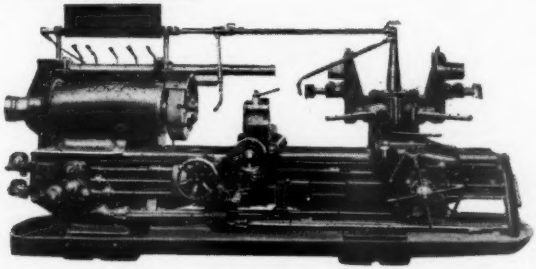

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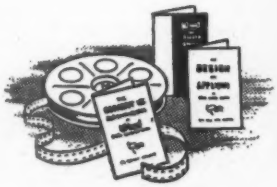

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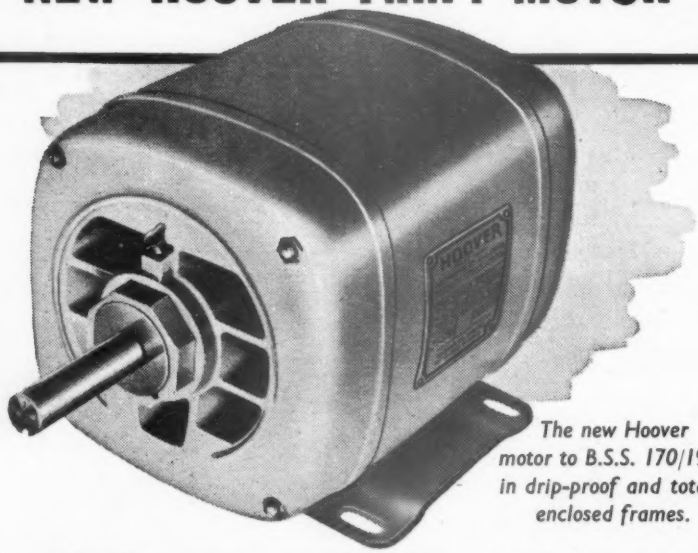

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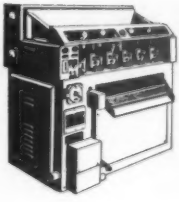

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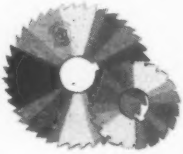

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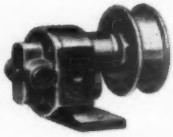

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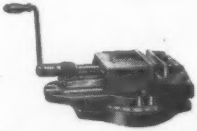

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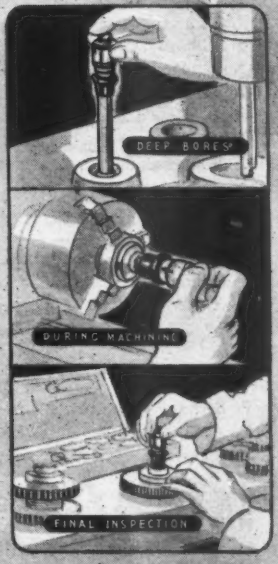

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FIRST ANNUAL SUMMER SCHOOL OF PRODUCTION ENGINEERING

St. Peter's Hall, Oxford.
Wednesday, 30th August, to Sunday, 3rd September, 1950.

The Theme for the School will be

THE SCIENCE AND PRACTICE OF ENGINEERING APPLIED TO PRODUCTION

Facilities will be provided for an interchange of views on specific aspects of production engineering, between those responsible for education and training and those in industry responsible for production. Particular attention will be paid to the development of teaching methods.

PROGRAMME

Wednesday, 30th August. P.M.	School assembles for Dinner followed by informal meetings of discussion groups.
Thursday, 31st August. A.M.	Opening address by Mr. W. E. Park, B.Sc. (Eng.), M.I.Mech.E., A.F.R.Ae.S., M.I.Prod.E., F.I.I.A., Chairman of the Summer School and Chairman of the Institution's Education Committee.
	A survey of the problems by Mr. T. B. Worth, M.I.Mech.E., A.M.I.E.E., M.I.Prod.E., Education Officer of the Institution.
	Lecture 1: 'Production Planning' by Mr. H. D. S. Burgess, M.I.Prod.E., Planning Manager of Humber, Ltd. Followed by group discussions and assembly for group reports.
P.M.	*Lecture 2:* 'Jigs, Tools and Fixtures', by Mr. R. L. Turner, who is in charge of T.W.I. training at the New Southgate works of Standard Telephones and Cables Ltd. Followed by group discussions and assembly for group reports.

P.M. *cont.*	After dinner address by Major-General K. C. Appleyard, C.B.E., T.D., D.L., J.P., M.I.Mech.E., A.M.I.Min.E., A.I.M.E., M.I.Prod.E., President of the Institution.
Friday, 1st September A.M.	Two parties leave college for works visits to either (*a*) Morris Motors, Ltd., or (*b*) Pressed Steel Co. Ltd.
P.M.	Free afternoon. After dinner address to be announced later.
Saturday, 2nd September. A.M.	*Lecture 3.* 'Production Processes' (Workshop Technology) by Dr. W. A. J. Chapman, Ph.D.,(Eng)., M.Sc.,(Eng). M.I.Mech.E., M.I.Prod.E., A.I.I.A., Principal of Hatfield Technical College. Followed by group discussions and assembly for group reports.
P.M.	*Lecture 4.* 'Work Measurement' by Mr. W. K. Hall, M.A., B.Sc., Head of Work Study Section of the Billingham Division of Imperial Chemical Industries, Ltd. Followed by group discussions and assembly for group reports. After dinner address to be announced later.
Sunday, 3rd September. A.M.	School disperses.

INSTITUTION NOTES

August, 1950

INSTITUTION DINNER The Institution Dinner is to be held on Wednesday, 4th October, 1950, at the Dorchester Hotel, Park Lane, London, W.1. when the President of the Board of Trade will be the Institution's Guest of Honour.

Members wishing to attend the Dinner are asked to make early application for tickets. (Evening Dress with decorations, or Dinner Jackets.) An Application Form for tickets was enclosed with the May Journal.

GRADUATE STUDIES IN ENGINEERING PRODUCTION The second post-graduate course of studies in the Principles of Engineering Production and Management, at the University of Birmingham, will extend from 2nd October, 1950, until 30th June, 1951, on a full-time basis.

The course provides advanced education and training for engineering graduates and others with equivalent qualifications, who intend to occupy executive, administrative and advisory positions, and who already have had satisfactory practical experience.

Preference is given to men sponsored by their employers and a number of senior scholarships are also available each year.

Further details are obtainable from the Secretary, Department of Engineering Production, or from the Registrar, The University, Edgbaston, to whom applications for admission to the course should be submitted not later than 15th August, 1950.

ANNUAL SUBSCRIPTIONS Members are reminded that annual subscriptions for the financial year 1950/51 became due on 1st July, 1950. Payments should be made to Head Office as soon as possible.

ACCEPTANCE TEST CHARTS Members are advised that Parts III and IV of the Acceptance Test Charts, published jointly by the Institution of Production Engineers and the Institution of Mechanical Engineers, are available from either body, price 5s. 6d. each. Parts I and II, however, are now out of print.

NEWS OF MEMBERS

Mr. John Cunningham, M.B.E., Member, General Manager of the Boiler Division of Ruston & Hornsby, Ltd., Lincoln, has been appointed a Director of the Company.

Mr. F. H. Flood, Associate Member, is now Works Manager to John Fowler (Leeds) Limited.

Mr. M. F. Jones, Associate Member, has been appointed a Director of Elfson, Ltd., Sutton Coldfield, of which firm he was formerly General Manager.

Mr. W. J. Mason, Member, is now Director of Ordnance Factories, Pakistan.

Mr. A. E. Ranger, Associate Member, has joined J. B. Manufacturing (Cabinets) Company, Walthamstow, as General Works Manager.

Mr. L. C. Seager, Associate Member, has been elected Chairman of the recently formed Salt Lake chapter of the American Society of Tool Engineers.

Mr. P. J. Shipton, Member, has been appointed General Manager of Elms Works, Wolverhampton, of J. Brockhouse & Co., Ltd.

Mr. R. Telford, Associate Member, has returned from Brazil to take up permanent residence in England, and is now Assistant to the General Manager of Marconi's Wireless Telegraph Co., Ltd., Chelmsford.

Mr. A. W. H. Walker, Associate Member, has joined the Work Study Section, Technical Department, of I.C.I. Ltd., London.

VISITOR FROM ABROAD Mr. S. E. Barratt, Member, and a past President of the Sydney Section, is paying a four months' visit to England and Canada in order to study manufacturing methods in the electrical industry.

Mr. Barratt, who is Director of Manufacturing for the Australian General Electric Pty. Limited, visited the U.S.A. and Canada on a similar mission in 1947.

OBITUARY The Institution deeply regrets to record the death of Mr. W. C. Clough, Associate Member, of the Yorkshire Section.

BOOKS RECEIVED "Engineering Drawing and Drawing Office Practice" by P. S. Houghton, A.M.I.Mech.E. Crosby Lockwood & Son, Ltd., London. Price 15s. net.

An up-to-date and comprehensive text book on general drawing office practice, containing useful material for the training of Student Engineers. Included are useful chapters on draughting for Machine Tools, Jigs and Fixtures, Press Tools, Small Tools and Sheet Metal Work.

Although the author makes full use of B.S.I. recommendations for Drawing Office practice, he goes further in his recommendations and conveys his own ideas.

A number of interesting items not seen in similar books are treated, among which may be mentioned the Ford decimal system of dimensioning and details of the new Unified Thread Form.

The sequence of chapters might be revised for future editions, as it was noted, for example, that sheet metal blank development was treated before conventional drawing practice. Also the layout of one or two of the drawing examples could be improved to save the reader the task of having to turn the book upside down in order to read the dimensions! Nevertheless, these minor points do not detract from the usefulness of the book, which is well printed and beautifully illustrated with line drawings, and is to be recommended as an authoritative work on the subject. A. A. F.

" Jig and Fixture Design " by H. W. Hardy, A.M.I.Mech.E. Sir Isaac Pitman & Sons, Ltd., London. Price 12s. 6d. net.

" Drop Forging " by Henry Hayes. Sir Isaac Pitman & Sons Ltd., London. Price 6s. net.

" Induction—Introducing Industry to the Individual ". Institute of Personnel Management. Price 2s. 6d. post free.

" Iron and Steel Directory and Handbook, 1950 ". The Louis Cassier Co., Ltd., London. Price 25s. net.

" The Industrial Safety Manual and Directory ". Practical Press, Ltd., London. Price 25s. net.

" Examples of Structural Steel Design to Conform with the Requirements of B.S. 449 : 1948 ". British Constructional Steelwork Association.

IMPORTANT In order that the Journal may be despatched on time, it is essential that copy should reach the Head Office of the Institution not later than 40 days prior to the date of issue, which is the first of each month.

ISSUE OF JOURNAL Owing to the fact that output has to be adjusted to meet requirements, and in order to avoid carrying heavy stocks, it has been decided that the Journal will only be issued to new Members from the date they join the Institution.

ADDRESSES OF MEMBERS

The list below gives the names of members whose addresses are not known at Head Office. Any information concerning the whereabouts of those listed would be greatly appreciated:

Aldham, P.M.S., A.M.I.Prod.E.
Allen, T. E., Grad. I. Prod.E.
Annear, William D. J., A.M.I.Prod.E.
Barclay, J., A.M.I.Prod.E.
Barclay, J., Grad. I.Prod.E.
Bass, J. W., A.M.I.Prod.E.
Bate, Ernest H., A.M.I.Prod.E.
Boards, Herbert S., Int.A.M.I.Prod.E.
Bones, Ernest G., A.M.I.Prod.E.
Booth, John, Int.A.M.I.Prod.E.
Bowen, W. H., M.I.Prod.E.
Breslauer, H. F., Stud.I.Prod.E.
Brook, Thomas B., Int.A.M.I.Prod.E.
Butler, William, Int.A.M.I.Prod.E.
Cashmore, R., A.M.I.Prod.E.
Charlesworth, G. V. S., Int.A.M.I.Prod.E.
Charlton, E. S., A.M.I.Prod.E.
Congrave, John L., Int.A.M.I.Prod.E.
Cook, John D., A.M.I.Prod.E.

Corbett, P. R., Stud.I.Prod.E.
Costello, R. E., Int.A.M.I.Prod.E.
Cubitt, R. H., Grad.I.Prod.E.
Dayal, Rameshwar, Grad.I.Prod.E.
de Reyghere, Roger, M.I.Prod.E.
Devonald, J. H., A.M.I.Prod.E.
Dodd, Eric W., Grad.I.Prod.E.
Duffield, E. A., A.I.Prod.E.
Duncan, R. A., A.I.Prod.E.
Edwards, J. H., A.M.I.Prod.E.
Edwards, S. J., Int.A.M.I.Prod.E.
Fairfax, R. S., Int.A.M.I.Prod.E.
Fitz, K. E. J., Grad.I.Prod.E.
Fitzhenry, Richard, A.M.I.Prod.E.
Freeman, T. H., Int.A.M.I.Prod.E.
Frost, A. F., A.M.I.Prod.E.
Fry, L. J., A.M.I.Prod.E.
Game, C., M.I.Prod.E.
Glaser, Peter, Stud.I.Prod.E.
Grey, Frederick, Int.A.M.I.Prod.E.
Groombridge, G. A. T., Stud.I.Prod.E.
Gunn, F. J., A.M.I.Prod.E.
Guy, J, A.M.I.Prod.E.
Hall, C. D., A.M.I.Prod.E.
Hampson, E. J., Int.A.M.I.Prod.E.
Hardy, Morris P., A.I.Prod.E.
Harman, Leslie G., Int.A.M.I.Prod.E.
Herbert, Henry B., Stud.I.Prod.E.
Hickling, Frederick R., A.I.Prod.E.
Hipwell, Arthur L., A.M.I.Prod.E.
Hollingsworth, H., Grad.I.Prod.E.
Hollman, Louis, Int.A.M.I.Prod.E.
Hook, K. G., Grad.I.Prod.E.
Horobin, D. H., Grad.I.Prod.E.
Horstmann, Bevan G., A.M.I.Prod.E.
Hughes, Alfred, A.M.I.Prod.E.
Husain, L. A., Grad.I.Prod.E.
Irving, Philip E., Int.A.M.I.Prod.E.
Johnson, J. E., Grad.I.Prod.E.
Kelsall, J. G., Stud.I.Prod.E.
Kendall, James K., M.I.Prod.E.
King, P. J., Stud.I.Prod.E.
Leach, John R. C., Grad.I.Prod.E.
Martin, Joseph, Int.A.M.I.Prod.E.
McGeady, L. D., A.M.I.Prod.E.
Miller, Charles A., Int.A.M.I.Prod.E.
Mitchell, D. V. F., Stud.I.Prod.E.
Narraway, S. D. J., A.M.I.Prod.E.
Naylor, J. W., Int.A.M.I.Prod.E.
Nugent, W., A.M.I.Prod.E.
Ottenborgson, J., Stud.I.Prod.E.
Page, Lt.-Col. A. W., M.B.E., M.I.Prod.E.
Parker, B. G., A.M.I.Prod.E.
Pickett, Arthur W. E., A.I.Prod.E.
Powell, W., M.I.Prod.E
Pollard, F. A., A.M.I.Prod.E.
Raaschou, R. E., Int.A.M.I.Prod.E.
Reay, Robert M., Int.A.M.I.Prod.E.
Richards, Edward S., A.M.I.Prod.E.
Riederer, R. F., Int.A.M.I.Prod.E.
Roberts, Harold U., Int.A.M.I.Prod.E.
Robinson, John B., A.M.I.Prod.E.
Roper, Harold, Int.A.M.I.Prod.E.
Rumley, John, Grad.I.Prod.E.
Scarborough, Ferdinando, A.M.I.Prod.E.
Seares, Charles W., A.M.I.Prod.E.
Seymour, George C. S., Int.A.M.I.Prod.E.
Sharp, W. H., Grad.I.Prod.E.
Sharpe, William F., A.M.I.Prod.E.
Sidhu, H. S., B.Sc.(Hons.), A.M.I.Prod.E.
Smith, P. H., Grad.I.Prod.E.
Smith, W. E., Int.A.M.I.Prod.E.
Spalding, T. H. F., Int.A.M.I.Prod.E.
Speck, E. H., A.M.I.Prod.E.
Spital, G. L., A.M.I.Prod.E.
Spottiswood, J. E., Stud.I.Prod.E.
Stanford, F. T., A.M.I.Prod.E.
Stone, W. L. J., Stud.I.Prod.E.
Swann, J. R., Grad.I.Prod.E.
Tilbrook, A. W., Int.A.M.I.Prod.E.
Timmins, C. W., A.M.I.Prod.E.
Tonks, B. S., Int.A.M.I.Prod.E.
Torkington, A., A.M.I.Prod.E.
Trotter, G. E., Int.A.M.I.Prod.E.
Turner, J. W., Int.A.M.I.Prod.E.
Watson, T. L., Stud.I.Prod.E.
Webster, C. F., A.M.I.Prod.E.
Webster, T. E., A.M.I.Prod.E.
Whalley, F. E., Int.A.M.I.Prod.E.
Wheeler, J. W., A.M.I.Prod.E.
Whitehouse, W. H., A.M.I.Prod.E.
Williams, J. E., A.M.I.Prod.E.
Wright, R., Int. A.M.I.Prod.E.

ELECTION OF MEMBERS

Meeting of Council, 27th April, 1950.

The following were elected to Membership by Council:—

As Members:

L. L. Allen, E. Biss, G. M. Butler, H. C. Cook, T. Coope, T. Cowling, A. Ewing, R. K. Fleming, G. Fowell, F. R. Francis, C. P. Halik, G. W. Hand, F. H. Harris, H. S. Holden, F. C. Holland, M. McK. Hunter, F. H. G. Lane, N. V. Larking, Brigadier R. B. Maxwell, D. H. McCormack, A. Metcalf, J. E. Oram, A. Smelt, S. A. Turner, F. T. West.

As Associate Members:

E. W. Allen, V. N. Allin, J. H. Arthur, E. Aspden, F. R. Ball, A. E. Barlow, T. Barton, S. Billington, D. B. Biltcliffe, R. O. Birch, J. H. Bostock, A. G. Boswell, P. H. Bowen, T. Bradbury, G. R. Brown, H. B. Burton, F. E. Caldicott, F. Caldwell, A. E. Carey, W. G. Cherrett, G. Clarke, R. M. Coomber, A. J. Cope, J. Cotterell, C. E. Darlington, G. B. Day, G. T. Deans, S. Death, T. A. Dennett, R. L. Dunn, J. Ekins, J. B. English, J. E. Farnden, A. H. Fineberg, G. D. Forbes, R. Frisby, R. M. Goulden, J. McL. Grant, H. P. Halfter, F. Hallworth, H. D. Hammond, W. A. Handley, E. C. Hennessy, C. Hibbert, R. G. Hitchcock, A. H. E. Houghland, J. Hulme, A. V. Houston, D. B. Jephcott, J. W. Jerome, W. P. Karnik, W. A. Knight, A. McL. Knox, R. G. Lawrie, W. A. Leeson, H. Lorton, J. B. Lovatt, W. H. Lovell, R. P. MacDonald, F. Mannion, R. W. Marks, M. Martins, A. H, Mason, F. E. Masters, R. A. May, J. J. Meyers, A. Moir, W. H. A. Moore. D. P. Mukherji, J. F. Nash, H. Nield, S. Nuttall, E. A. Patston, J. R. Pledger, H. J. Plummer, E. Powell, J. F. Randall, L. Richardson, R. G. Richardson, D. C. H. Robertson, H. W. Robinson, J. W. Row, J. Rowley, J. Roznack, G. Scholes, F. Sheldon, P. A. Sidders, H. Smith, G. T. Spence, D. W. R. Spurging, R. N. Stallard, J. Stevens, R. B. Stevenson, J. D. Sumner, T. V. Sundaresan, J. Sutherland, B. E. Taylor, H. G. Taylor, E. A. Tester, J. A. Thomas, W. H. Thompson, W. T. Tourell, H. A. Turner, F. W. Tweddell, P. J. Waldron, J. Wallace, A. W. Warner, F. Westall, R. White, C. G. S. Williamson, G. S. Wilson, A. G. Wood.

As Associates:

R. Archer, H. A. Gordon, C. Powney, A. R. E. Singer, W. R. Talbot.

As Graduates:

M. Amir, H. Bainbridge, D. S. Beck, L. Bell, P. K. Bhattacharya, P. Binks, A. Bone, G. C. Brandon, A. J. Brock, J. Burton, P. H. F. Burton, R. Cameron, C. Carr, A. E. Clarke, P. G. Collishaw, F. W. G. Connew, M. Daniels, L. A. Darby, M. D. Davis, D. Derozhinsky, D. S. Dugdale, S. J. Eaton, K. Ellard, J. S. Ellis, A. Evans, L. Evans, F. E. Farnworth, L. J. Farran, P. W. G. Faulkner, W. R. Gaudion, G. S. German, J. L. Gillborn, L. S. Goodhall, S. A. Grant, J. R. Haddow, R. W. Hall, R. W. Hammond, L. H. W. Harris, J. Hayes, F. E. Humble, A. J. Lamb, W. F. Laverock, J. A. Loudon, K. Macdonald, T. D. Martin, D. H. May, P. H. D. McGain, K. I. McKenzie, K. E. Miles, V. L. Moffatt, K. L. Morgan, D. P. Mortimer, M. L. Mukherjee, R. J. Mutton, E. S. Nichols, J. Norrie, L. E. Norton, J. G. Oxnam, G. C. Pitt, J. F. Pullen, W. M. Rimmer, J. G. Sanchez, J. Shephard, J. Simnett, N. P. Stanley, C. D. Swain, E. C. Tetsull, J. D. Tittley, L. Tolman, F. H. Treglown, W. C. Tucker, J. Waddington, D. F. Waters, R. Westall, C. Windle, C. L. Wright, C. W. Wykes, R. C. Yarnell.

AS STUDENTS:

A. Alsop, G. J. Aries, J. H. Beddard, H. Benyon, N. Bolton, S. Brown, W. Bruce, E. Bullock, N. J. Bullock, L. Burgess, V. F. Burgess, S. G. Crooks, H. W. Curtis, J. R. Davies, M. S. Davis, J. C. Dunster, F. G. Ethelston, J. F. Everett, A. E. Frost, D. K. Glover, J. H. Grey, B. W. Griffin, M. J. Harvey, E. J. Hathaway, P. D. Hedgecock, F. L. Hiles, W. Howarth, D. J. Hutcheson, R. L. Hutchinson, R. S. Jagger, K. Janes, I. John, R. King, D. A. Lamb, L. A. LeBreton, M. A. Leeke, F. A. Martin, D. H. Mathew, A. D. Nicholls, H. E. A. Noble, W. N. O'Brien, L. Owen, J. E. Palmer, E. W. Pearson, S. Pearson, M. R. Pengelly, C. Peters, R. F. Peters, D. E. Pritchard, E. D. Quiddington, J. H. Rose, R. Sarjanston, D. R. T. Seward, M. J. Strevens, T. J. Sullivan, N. A. Tomkins, J. E. Walton, A. J. R. Waters, A. E. R. Watkins, J. Wearmouth, L. R. Wells.

NEW AFFILIATED FIRM:

The Standard Motor Co. Ltd.,

AFFILIATED REPRESENTATIVES:

H. H. Jackson, T. Reeve.

TRANSFERS:

FROM ASSOCIATE MEMBER TO MEMBER:

E. H. Y. Burden, G. E. Dance, I. G. Hopkinson, J. Pound, W. E. Revell, W. G. Rodgers, S. C. Tucker, J. H. Winskill.

FROM ASSOCIATE TO MEMBER:

J. L. Hardy.

FROM INTERMEDIATE ASSOCIATE MEMBER TO ASSOCIATE MEMBER:

W. J. Ager, F. W. Allen, R. Ashby, E. R. Baller, J. W. S. Bambrough, A. D. Banks, A. C. Bhattacharya, E. Boneham, W. E. Bracewell, T. J. Brennan, J. E. L. Brown, W. L. Bruchhauser, K. C. Buteux, D. J. Carlisle-Kitz, F. C. Carter, P. Chambers, W. Clark, S. A. F. Court, D. Croft, H. Davenport, G. E. Dodd, A. E. Dodson, W. S. Dodson, A. S. Downes, K. J. B. Dunn, F. Dutton, J. Evans, R. H. Fenton, E. A. Fry, N. S. Garcha, E. Gascoigne, E. George, R. Gore, J. Hampton, E. Harescough, E. A. Hearn-Cooper, A. Heaton, G. W. Hems, J. R. Hicks, D. S. Hitchins, J. A. Holinger, J. C. Holmes, H. Hull, J. W. Ironside, F. W. Johns, K. H. Johnson, L. E. Jones, L. W. J. Lait, L. Lamb, F. M. Lumb, D. Mackey, G. Maluganni, J. D. Mantle, R. Mulholland, P. H. Muller, J. Napier, G. Pilcher, A. L. Preston, L. W. Rendlesham, G. Robertson, L. C. Seager, S. Smith, J. M. Thirlwell, A. Tildsley, A. D. Turner, H. White, E. Wilkinson.

FROM ASSOCIATE TO ASSOCIATE MEMBER:

G. B. Leather.

FROM GRADUATE TO ASSOCIATE MEMBER:

W. A. Ashfield, E. W. Beever, J. D. Berry, H. Bolton, J. D. Briggs, I. T. Clowes, S. J. Cotton, D. J. Hallam, E. Jackson, G. Leech, J. A. Messenger, J. W. I. Noble, T. H. Perrin, G. H. Spratt, W. C. Wallis, E. Ward, B. G York.

FROM STUDENT TO GRADUATE:

G. L. Ball, M. L. Bentley, B. Burkinshaw, M. H. Choules, E. N. Coates, W. R. Coleman, A. E. Davis, D. I. Gray, H. Handley, G. H. Horne, P. H. J. Johnson, S. F. Ling, R. Morris, P. J. Mullins, J. Parkinson, F. Reynolds, W. C. Rowbottom, J. F. Townsend, E. Walker, K. Walmsley, R. V. Whateley, L. A. White, M. Williams..

WORKS ORGANISATION for RESEARCH and DEVELOPMENT of AIRCRAFT ENGINES

by J. S. PAGET, B.A.,(Cantab.), A.M.I.Mech.E., M.I.Prod.E.*

Presented to the London Section of the Institution, 16th February, 1950

IN the past session you have heard of some of the manufacturing problems met with during the process of research and development of aircraft engines and the methods adopted to overcome them. This evening I propose to say something of the problems of works organisation met with in the same field.

These are largely brought about by the fundamental difference in the function of the Works Departments in a research and development unit as distinct from a purely manufacturing unit.

In the latter case, the final product of the firm is an aero engine or a washing machine, or a complete power station, according to the concern. The output of the works can be roughly measured in the weight of raw material converted into finished and assembled products. Similarly, its efficiency can be gauged by comparing the total annual turnover with the manufacturing costs, machine tool utilisation, output per square foot of floor space, maximum ingenuity of methods to reduce skilled and overall labour content, and many other normal criteria of organisational efficiency.

The firm's bread and butter is earned by the works making things for sale to its customers, and the function of the Design, Development and Drawing Office Departments is to provide the works with drawings of products which the firm's customers will buy. It can therefore be said that the technical functions on the one hand, and the sales functions on the other, comprise Service Departments to the works, and that their main purpose in life is, between them, to keep the works fully employed.

This statement might be regarded as an over-simplification as applied to some concerns, but I think that in the main it is true.

Turning now to a purely Research and Development Unit, the final product of the organisation is not now engines for sale to the customer, but a set of drawings of an engine which, at the end of its first phase of development, has proved itself to be capable of meeting its specification as to power at sea level and altitude, specific consumption of fuel and oil, weight, frontal area and flying time between overhaul. Further development will probably continue if

* *Manager, D. Napier & Son, Ltd., Acton.*

The Institution of Production Engineers does not accept responsibility for any statements made or opinions expressed in any papers published in the Journal of the Institution.

the engine is successful, in order to improve on the original design rating, but we need not consider this phase at the moment.

Engines which have reached this phase of development would then be considered as suitable for sale direct to customers and would be handed over to the normal manufacturing organisation to be treated in the normal way.

Since the final product of a Research and Development Unit is a set of drawings and process specifications compiled by the Technical Departments, the work of the Production Departments must be considered as a service to the Technical Departments, that is to say, the Production Departments have to translate the ideas of the Technical Departments into ironmongery and arrange for them to be tested to see if they work. This conception can best be understood by briefly considering the life-cycle of an aero engine from its inception up to the stage of going into production.

In the first place, a requirement is stated, either by the airframe manufacturers or the firm, as to the overall specification the engine has to meet. The Project and Performance Departments then get out a number of alternative schemes showing the various ways in which they think the specification can be met. A high level decision is then taken by the Chief Engineer, with the advice of his staff, as to which alternative to go for. Preliminary design data and overall layout drawings are then made and a brochure prepared setting out the above information, together with estimates of cost and time involved.

WORK OF PRODUCTION DEPARTMENTS This is the first stage at which the Production Departments come into the picture.

They are responsible for providing the estimate of cost involved in making a limited number of prototypes, generally between two and six, according to the size of the engine, the cost of tooling and time required for manufacture. This I shall call the " Brochure Stage ".

The judgement required at this stage is considerable, as in the first place, the whole project is generally extremely confidential and therefore only the minimum number of people must be involved. Secondly, the amount of information available is very slight, so that the job has to be done by one of the most senior production engineers, if not the Department Head himself, by instinct based on previous experience rather than by any very scientific build up of pre-cost.

The brochure is then submitted to the Board of Directors, and when accepted, the full design work can proceed.

The Production Departments now have a very important role to perform—that of close contact with the Design Offices—to ensure as far as possible and at the earliest possible stage, that the parts designed can be made at reasonable cost when the engine eventually

goes into production, and also to formulate any long term plans that may be necessary to get the prototype made.

As each design scheme for the various parts of the engine is completed, it is vetted and signed by or on behalf of the Chief Production Engineer and is passed to the Main Drawing Office for detailing and is then issued to the shops for manufacture.

Generally, the complete engine is not issued for assembly in the first instance, but the various units are issued separately for individual testing and development prior to fixing the design standard for the first complete engine.

In parallel with the design and manufacture of the units of a prototype, the various test facilities have to be designed and made, and this is frequently a bigger job than the design and manufacture of the units or engine itself. When I tell you that it is not uncommon to require up to 20,000 h.p. to drive an axial compressor, you will appreciate that the provisioning of the Test Plant is no small problem !

When the prototype units or engines are made and have completed a low duty acceptance test, they are handed over to the Development Departments and the " Development Stage " begins.

DEVELOPMENT STAGE Now comes the most testing time for the Production Departments and the one which shows up the greatest divergence between a purely Manufacturing, and a Research and Development Unit. Generally, a new engine is designed incorporating many ideas which have never been proved and many features which the designers hope will work, but of which they cannot be sure. Unless this were so, aero engine technique could not progress at the rate it does.

It therefore follows that many changes will be made to the prototype engine in the course of development and these changes will all be wanted in a *hurry*.

The normal procedure is for the prototype to be put on test, when certain problems will be shown up either on performance or mechanical design. The Development Department, in conjunction with other departments as necessary, will decide the next step and request new parts to be made. Now until the parts *are* made and the engine reassembled and put back on test, they cannot *know* whether the new ideas are right or wrong. It can therefore be appreciated that speed is the essence of the contract and that if the firm has several major projects in hand, all in various stages of development, the requirement of new parts is considerable and all of them are wanted " yesterday ".

In addition to the development teams working on various aspects of units, engines, fuel systems, etc., the Research Departments working on fundamental problems require specimens and test

equipment urgently. The Test Plants will also require modification as new requirements discover themselves.

All these requirements are wanted immediately, as the rate of development is, in the end, the rate at which new parts and designs can be made and tested.

Many first class engines have never gone into production because their development was too late to meet airframe requirements, and other, and in some cases inferior, engines have been adopted only because the development timing was wrong.

This process of development continues until the engine has passed its type test and is fit to go into production—maybe in a different factory—but before this occurs, the Research and Development Unit, in conjunction with the Planning Department of the Manufacturing Unit, must consider the general machine tool and space requirements, with particular reference to special purpose machine tools and long delivery equipment.

In many cases, pre-production batches of engines are required for prototype or pre-production batches of aircraft, and these will generally have to be provided by the Research and Development Unit.

Summarising therefore, the cycle as it concerns the Production Departments is as follows:—

(1) Brochure Stage, i.e. estimate of cost and long term plans for prototype manufacture.

(2) Design vetting and medium time plans for prototype manufacture.

(3) Manufacture of prototype and Test Plant.

(4) Development Period with urgent supply of new parts.

(5) Long term production requirement and manufacture of pre-production batches.

Having stated the problem, I will now deal with the fundamental difference in the production set-up of a Research and Development Unit as against a Manufacturing one, made necessary to solve, as nearly as possible, the problems propounded.

MANUFACTURING EQUIPMENT The manufacturing equipment, machine tools, heat treatment plant, protective treatment, inspection equipment, etc., must be versatile. The exact size, shape and machining/hour mixing of components to be produced will not be known in the main when the Shop is laid down, and therefore the plant must be able to make any shape of part within the general size limitation of the class of engines envisaged. There will of course be certain specialist sections according as to whether the firm is developing reciprocating or gas turbine engines, and special equipment will be required to produce such things as crankshafts or

turbine and compressor blades or impellers. Most casings will be in light alloy and therefore the larger machines will have to be capable of high cutting speeds.

Certain machines will never be fully loaded but due to the urgency of most of the work, will earn their keep with a low machining/hour loading if they are available to make their particular contribution when wanted.

Certain special purpose machines will have to be developed and even made by the firm, but I will deal with these later.

A fully equipped Standards Room must be maintained, capable of measuring parts to very fine limits, both for control of manufacture and for investigation work such as ascertaining wear after running, erosion of turbine and compressor blades, etc.

Allied to this are the Laboratory Departments which, quite apart from pure research and development into materials and processes, must have chemical, metallurgical and radiographic facilities for control and investigational purposes.

Heat treatment facilities must also be available for hardening treatments such as carbonising, nitriding and induction hardening, and the normal annealing and stabilising of ferrous, non-ferrous and light alloys. This department, together with a plating shop capable of a wide range of plating operations for protection and building up, and including such operations as chromising and anodising, must be under strict laboratory control.

Although few firms have facilities for making all their own castings and forgings, a small forge and foundry is essential for the speedy manufacture of development parts. In this connection, such processes as investment castings and powder metallurgy cannot be overlooked.

Although a wide range of articles both finished and in raw material state have to be obtained from specialist firms, the less one has to rely on them, the quicker will development proceed.

LABOUR We now come to the question of manufacturing labour, and it will be readily appreciated that in the main, this will have to be highly skilled.

Although a fair amount of special tooling has to be made in order to manufacture certain parts at all, as far as possible this is kept to the minimum. Accuracy and interchangeability must however be maintained, and this in many cases will depend on the skill of the operator, although machines like the DeVlieg Jigmill can help in reducing this.

Right from the beginning the aim must be to keep hand fitting on assembly to the minimum, so that units and parts can be interchanged between engines. Many parts cannot be allowed to stand between one day shift and the next, and it is therefore necessary to

have two, and in some cases three shifts on certain machines.

On some of the more complicated casings on horizontal and vertical borers, we found that time was being lost due to one shift having to check over the casing to find out how the previous shift had left it. To overcome this, we introduced a double day shift with one hour's overlap between 3 and 4 p.m.

Although this meant two men booking on the same job for one hour in the twenty-four, we found that the saving in time cost was large, due to the daily contact between the two operators.

In these days it is no easy matter getting suitable labour for this class of work, especially for night shift, as by no means all time served men are able or willing to undertake it.

This puts even greater emphasis, if emphasis be needed, on apprentice training to ensure a steady flow of suitable craftsmen as well as other grades of technical and productive personnel, without which no organisation can be healthy.

ORGANISATION

Coming now to the question of organisation, in the main it follows that of a conventional factory, so that I will not discuss the full organisation layout from the Board of Directors to shop labourer, but will concentrate on the pre-shop functions, i.e. those departments dealing with the job between the issue of drawings from the main drawing office and the starting of the manufacture on the shop floor.

The authority for manufacture is issued by the main drawing office, together with the drawings, and can be termed a Batch Sheet. Fig. 1 shows such a document and you will see that it gives all relevant information as to quantity, job number, material, etc., and that there is an extension sheet on the right hand side for the use of the Progress and other departments to save transcription of the information on to other pieces of paper for their own particular use.

The drawing and Batch Sheet are therefore the official start of the manufacturing cycle, although in many cases, part of the work has started on advance information.

For instance, the ordering of special material, castings and forging, will be done direct by advance requisition from the main drawing office to the stores and supply department, and in the case of castings, the pattern makers will have started work before the detail drawings are finished, and will be fed with information as it becomes available.

The main pre-shop functions come under the control of the Chief Production Engineer, who is responsible to the Manager and Fig. 2 shows a representative set-up.

I will deal with these departments reading from left to right:

The Chief Planning Engineer co-ordinates the following functions:—

BATCH SHEET

3 TYPE T.B. 20 BATCH IND. CHARGER SHEET No. B1
PARTS REQUIRED FOR TURBO CHARGER COMPONENT

JOB No.	ALL LABOUR & MATERIAL CHARGED TO	D.O. 186	RE-ISSUE / DATE / ALTN.

PART No.	DESCRIPTION	QTY. PER SET	SPARES TOTAL	MATL.	REMARKS
	TURBO CHARGER COMP. SHAFT GROUP				
TC.1033	Shaft - Impeller	1		H.W	50/55 Rkw
TC.1038	Impeller	1		DTD.420	Dry Stamping
TC.1039	Sub-assy. of Rotor Disc and Blades Complete	1			
TC.1041	Disc	1		[illegible]	[illegible]
TC.1051	Blade	30		1276	NPC 8-4th 4S1307
TC.1042	Bolt - adjusting	2		[illegible]	[illegible]
S.-115/21	Peg - Skin	2			
TC.1038	Nut - Rotor Disc	1		[illegible]	[illegible]
TC.1057	Stopper - Tab	1		[illegible]	[illegible]
TC.1058	Bearing - Ball	2			[illegible]
TC.1059	Nut - Shaft End	2		[illegible]	[illegible]
TC.1030	Bumper - Grooved	2		[illegible]	[illegible]
	COMP. CASING GROUP				
[illegible]	Casing - volute	1		[illegible]	[illegible]
[illegible]	Ferrule - 12" Exhaust Ring	1		[illegible]	[illegible]
[illegible]	Ring - ferrule	1		[illegible]	[illegible]
[illegible]	Nut - Fixer	6		[illegible]	
[illegible]	Bolt	6		[illegible]	
[illegible]	Washer - Tab	6		[illegible]	
[illegible]	Distance	4		[illegible]	[illegible]

3 TYPE T.B. 20 BATCH IND/CHARGER SHEET No. B.I.

COMPILED PFJ/RFC	CHECKED [illegible]	DATE OF ISSUE APPROVED 14/2/50 [illegible]	PROGRESS CHASER [illegible]

Fig. 1. Batch Sheet.

(1) *Production Co-ordination.*

This department receives the Batch Sheets from the main drawing office and is generally responsible for all detailed programme planning and pre-shop progress.

The Batch Sheets are checked for material not ordered in advance, but likely to cause delay, and if necessary, it arranges for alternatives in conjunction with stress office and laboratory. Part numbers are checked to see if operation layouts exist, and if not, a demand is raised on the operation planning section. This is in the form of a card which calls for each function of planning and jig and tool drawing office, and issue of production orders on the shop, to be carried out by certain dates, and the department is responsible for seeing that these dates are kept. It also prepares the manufacturing programmes for the shops, in fact the key-note of this department is " dates ".

When dealing with rapid flow of parts through the shop and the necessity of co-ordinating various development schemes with their appropriate test plants, etc., any system based on priorities quickly defeats itself. Everything eventually gets on to top priority and new

symbols have to be invented to indicate yet higher priorities. It is therefore essential that all programme planning is in terms of dates, but these, to be effective, must be realistic. If programmes are issued which are blatantly impossible to keep, all confidence in all programmes is lost and nobody really tries to keep any of them.

The mechanism by which these programmes are made is as follows:—

On major projects, including manufacture of new prototypes, test plants, etc., the project as a whole is discussed between the design staff and the Chief Production Engineer at the very earliest stage. The project is broken down into convenient units and all matters affecting the programme are taken into consideration, such as time required for design and detailed drawings, material delivery, tooling, machining and assembly cycles.

From this a target programme is prepared, a representative sample of which covering the manufacture of a new range of exhaust Turbo Supercharger, is shown in Fig. 3.

The work of designing and detailing then proceeds, material not in the stock list is ordered and delivery promises obtained. Further, advance information is obtained as to the problems likely to be encountered in machining and assembly.

When the parts are detailed and batched, the job of preparing the manufacturing programme begins. A representative sample of this is shown in Fig. 4. Whereas the target programme was, in

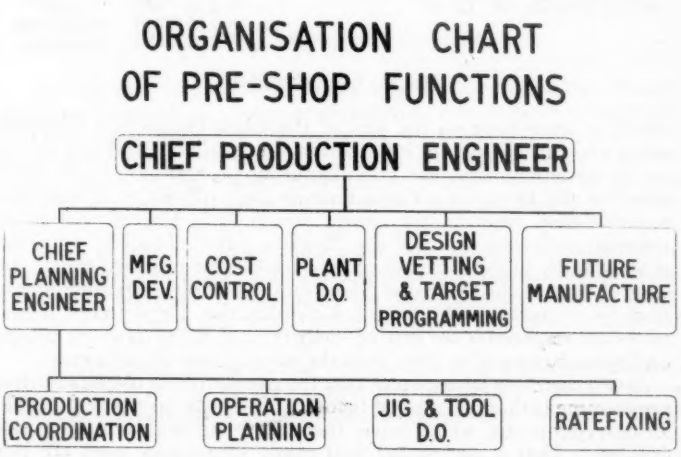

Fig. 2. Organisation Chart of Pre-shop Functions

TARGET PROGRAMME

T.B. 20 TURBO BLOWER

SCHEME DRG. AND ITEM Nº	DESCRIPTION	DWGS		MATERIAL				OP. LAYOUT	TOOLS		MACHG		ASSY	
		SCHEME	DETAIL	CASTING	FORGINGS OR STAMPINGS	BAR OR SHEET	O F		DESIGN	MANUFG	START	COMPLETE	START	COMPLETE
	COMPRESSOR CASING GROUP													
A22-1033														
Item 1														
3														
4														
6														
	COMPRESSOR SHAFT GROUP													
A22-1033														
Item 63														
65														
67														
72														
73														
77														
	TURBINE SHAFT GROUP													
A22-1033														
Item 91														
93														
95														
96														
98														

SUMMARY

DETAIL DRAWINGS COMPLETE BY	14.2.50.
CASTINGS, BLADE MATERIAL, AND FORGINGS, REQUIRED BY	1.7.50.
TOOLING COMPLETE BY	14.4.50.
MACHINING COMPLETE BY	31.7.50.
UNIT ASSEMBLED FOR TEST BY	31.8.50. 1ST UNIT
	14.9.50. 2ND UNIT
	30.9.50. 3RD UNIT

H.L. Gillespie
CHIEF PRODUCTION ENGINEER

Fig. 3. Target Programme.

effect, a pious hope on the part of the Chief Production Engineer when very little concrete information was available and was issued on his authority only, the manufacturing programme, while compiled by the Production Co-ordination Department, is agreed and signed before issue by the Stores and Supply Department as to material deliveries, and by the Progress Superintendent as to the practicability of the parts being produced in the required time. In case of doubt, the Machine Shop and Assembly Superintendents may be consulted. Production Co-ordination Department themselves are responsible for getting confirmation of the dates for design and manufacture of tooling from the appropriate departments.

It will therefore be apparent that the essence of the manufacturing programme is that it is agreed before issue by the people responsible for carrying it out, which leaves them no legitimate alibi if it is not fulfilled. That is not to say that many illegitimate ones are not produced from time to time !

MANUFACTURING PROGRAMME

Nº 150/1

TB.20 TURBO BLOWER
WORKS ORDER-ZB 46732
D.O. 1668.

PT Nº	DESCRIPTION	BATCH SHEET Nº	MATERIAL: CASTINGS	FORGINGS OR CASTINGS	BAR OR SHEET	B.O.F.	PRODUCTION ORDERS ISSUED	TOOLS: DESIGN	TOOLS: MANUF.	MACHINING: START	MACHINING: COMPLETE	ASSEMBLY: START	ASSEMBLY: COMPLETE
	COMPRESSOR SHAFT GROUP												
[illegible]	[illegible]	B.1			avail		28-2-50	28-2-50	10-3-50	1-4-50	22-4-50		
[illegible]	[illegible]	B.1		8-4-50			28-2-50	28-4-50	10-5-50	20-5-50	28-6-50		
[illegible]	[illegible]	B.1					28-2-50	28-4-50	10-6-50	27-7-50	3-8-50		12-8-50
[illegible]	[illegible]	B.1		28-2-50			13-2-50	28-4-50	10-6-50	23-7-50	31-7-50	10-8-50	21-8-50
[illegible]	[illegible]	B.1		14-3-50			13-2-50	28-2-50	10-4-50	13-7-50	27-7-50		30-8-50
[illegible]	[illegible]	B.1			avail		28-2-50			23-6-50	13-7-50		
[illegible]	[illegible]	B.1				@	3-3-50						
	Details	B.1					2-3-50			23-6-50	14-7-50		
	COMPRESSOR CASING GROUP												
[illegible]	[illegible]	B.2	30-6-50				28-2-50	14-3-50	21-4-50	13-6-50	31-7-50		1-9-50
[illegible]	[illegible]	B.2	28-3-50				17-4-50	14-3-50	28-4-50	28-7-50	31-7-50	2-8-50	1-9-50
	Details	B.2					28-2-50			13-6-50	31-7-50		30-8-50

* Jig and Tool Offices please note that swarf must be placed in cover immediately to meet this date

@ Provisional, unfortunately items note that an agreement on this date must be obtained otherwise Assembly and Test of this will be delayed.

TURBINE GROUP													
Desc. Sheet 6													

PRODUCTION CO-ORDINATION DEPT.			CH. PLANNING ENG.	APPROVAL BY HEADS OF DEPTS					
COMPILED	DATE	PASSED	DATE	APPROVED	DATE	PROGRESS DEPT.	MAT: CONTROL	JIG & TOOL DESIGN	Nº OF SHEETS 2
[illegible]	14 3 50	[illegible]	15 3 50	[illegible]	15 3 50	[illegible]	[illegible]	[illegible]	SHEET Nº 1

Fig. 4. Manufacturing Programme.

Should the circumstances under which the programme is made alter considerably, i.e., change of design or non-delivery of material, then the programme can be re-issued.

In order to assist in their compilation, a detailed weekly return of shop load is made, broken down into machine types (Fig. 5). In addition, a continuous estimated forward load is maintained by the Chief Production Engineer's assistants.

To complete the programme cycle, the Progress Department is responsible for seeing that programmes are maintained and for reporting on those items which are not likely to be met, giving reasons, and monthly high level meetings are held to review the progress of projects as a whole.

Summarising therefore, the Production Co-ordination Department is responsible for seeing that the shops have manufacturing instructions and dated programmes to enable them to do their part. (Fig. 2).

We now come to:—

MAN HOUR LOADING STATEMENT

(BASED ON OPERATING TIMES EXTRACTED FROM WORKS TICKETS)

WEEK ENDING 20th. OCTOBER 1947

	ALL GROUPS	TURNING	MILLING	GRINDING	DRI
LOAD OUTSTANDING FROM PREVIOUS WEEK	6.086	1.176	1.203	2.688	1(
LOAD ISSUED THIS WEEK	236	128	85	13	
LOAD COMPLETED THIS WEEK	874	207	202	290	
CAPACITY (BASED ON 40HR. WEEK)	1.000	240	200	36	
AVERAGE LOAD COMPLETED 4 PREVIOUS WEEKS	979	234	260	2	
LOAD CANCELLED OR SCRAPPED	—	—	—		
LOAD OUTSTANDING — HOURS	5.448	1.097	1.086		
LOAD OUTSTANDING — WEEKS (BASED ON 4WKS. AVERAGE)	5½	4½	4¼		

Fig. 5. Man Hour Loading Statement.

(2) *The Operation Planning Department.*

This department makes all operation layouts employing normal engineering techniques and machine tools as distinct from specially developed techniques and machine tools which are dealt with by the Manufacturing Development Department. It is also responsible for estimating the floor to floor time for all operations.

(3) *The Jig and Tool Drawing Office.*

This department, as you would expect, is responsible for designing the manufacturing equipment called for on the operation layouts and for providing draughting facilities for the Manufacturing Development Department.

Next we come to:—

(4) *The Ratefixing Department.*

The problem of ratefixing in a one off experimental shop is naturally difficult and some people maintain that it is not worth while, and that one would be better advised to work on a day work basis.

Although it is not possible to go in for any advanced form of time and motion study, and even normal timed demonstrations are not generally practical due to shortness of batches, it does give a margin of control over day work under present conditions, which I think pays for the cost of running a Ratefixing Department, apart from giving greater accuracy in job cost recording and estimating.

Some method must be found of relating an operator's performance to his pay, and the alternative of varying base or merit rates according to skill and speed can be more controversial even than ratefixing of individual jobs.

Every operation before issue has a time on it based on the planner's floor to floor estimate, to which the Ratefixing Department adds allowance for handling, set-up, fatigue and bonus earning.

The operator has the usual right to object to the time after he has started it, and it is most essential that any extra time must be given before the job is finished. There is a continual battle to keep the number of tickets made up after completion to an absolute minimum, and this is the real key to providing a true incentive. Where extra time has to be given, the ratefixer records the reason under one or other of eleven different code numbers, and the results are kept under constant review.

We turn now to the other functions under the direct control of the Chief Production Engineer and the next one we come to is the Manufacturing Development Department.

MANUFACTURING DEVELOPMENT DEPARTMENT

This department, as I have already stated, is responsible for the development of non-standard manufacturing techniques and machine tools including, in some instances, the design and development of special machine tools, either on their own, or in conjunction with machine tool manufacturers. In addition, it provides such services as general information on the best current methods of production as gleaned from technical publications of all countries, expert advice on such functions as grinding and broaching, the optimum tool rakes and angles and cutting feeds and speeds for new materials, etc., etc.

It may be called upon to solve problems associated with either particular operations in the manufacture of a component, or with the complete cycle of operations on such components as turbine and compressor blades—the thorniest problem for firms engaged in gas turbine production. When the problem is solved, or at any rate one reasonably acceptable solution is found, the whole procedure is recorded in the form of a Process Specification. This can then be called up on operation layouts by the Planning Department as a standard technique.

One very important function of the Manufacturing Development Department is to provide advice to the Design Departments, and

in some cases to arrange for the manufacture of sample methods of construction for test purposes. This applies particularly to fabricated components.

To give a complete list of the problems they have to deal with would take up more time than I or you have at our disposal, but I hope that the examples I have given will give you a general idea.

The organisation of the department differs fundamentally from that of the departments under the control of the Chief Planning Engineer, and is based more on that of a Research Department. That is to say that the problems are allocated to teams of one or more members of the department, and apart from solving the problems, they have to issue monthly reports on how they are getting on, giving not only positive, but also negative results, so that over a period, a goodly store of manufacturing information is recorded.

As my firm is part of a large group, some of this information is of general interest, particularly in such matters as optimum tool and machining conditions for new materials etc.

In the selection of personnel for this department, the aim should be to achieve a nice balance between people with long experience on the shop floor and the young ex-student or ex-graduate apprentice, who can bring a more scientific approach to the subject. Not infrequently one of each type is teamed up together to get a blend of theory tempered by practice. This also provides a very good training ground for young engineers.

The size of this department is limited only by space and money, as its field of activity can be almost unlimited, in fact, I frequently wish I could consign all administration and paper work to the Devil and get down to some of the problems myself, although whether this would increase the efficiency of the department is a matter of conjecture !

COST CONTROL Next we come to the Cost Control Department. The problem of cost control in a Research and Development Unit is extremely difficult. Estimates for prototype manufacture have to be provided at the brochure stage on very scant information, and as development proceeds, things happen which cannot be foreseen and which can only be covered in the first place in a very general way.

Certain fundamental principles are involved. In the first place, true cost control is not merely the provision of a set of figures, but is the action taken by responsible officials to ensure that a predetermined technical result is obtained for a predetermined amount of money. The Cost Control Department has to provide the best possible information to those officials in potted form, to enable them to take action immediately an adverse trend is discovered. This applies at all stages: design, detailing, provision of jigs and tools, purchase of material, machining and assembly.

Basically, the information required is—amount of estimate, total spent, and percentage of completion for that expenditure. To be of any use, the information must be absolutely up to the minute. If it arrives six or eight weeks after the event, all one can do is to have a good ' cry '. What is required is the projection of immediate trends, which in effect say, " If you don't do something now, in a month's time you will be over-spent ".

For this reason, the Cost Control Department can best work in terms of man hours, not £ s. d., and is therefore within the Chief Production Engineer's purview rather than that of the Chief Accountant.

Costs arrived at by pure accountancy methods are inevitably delayed, as the first operation on piece-work bills, time sheets and invoices must be payment of wages and invoices. Returns from the accountants are however very valuable as a cross check on the information from the Cost Control Dept.

A further reason for placing the department under the Chief Production Engineer is that its personnel must be Production Engineers rather than Accountants. This is not meant to be disrespectful to accountants, but an essential part of their duties must be a preliminary investigation, if necessary on the shop floor, to show the causes of any adverse trend.

It is not possible tonight to give full details of the system, as the subject deserves a lecture on its own, but the main sequence of events, as in the case of a new prototype for instance, can be stated as follows:—

In compiling the Brochure Estimate, the project is split into convenient units, generally parts which can form sub-assemblies. Each unit is then estimated in respect of design and detailing; patterns and dies; design, material and labour on tools; manufacturing material and labour ; bought-out parts and assembly.

When the design schemes come to the Chief Production Engineer's Department for vetting, they are re-estimated in the light of more detailed knowledge, so that before any appreciable amount of work is done in the shops, a clear picture can be obtained as to how one is likely to stand in regard to the Brochure Estimate, and appropriate action taken if the picture is not satisfactory.

When all parts are detailed and batched, the planning layouts are prepared and the estimated ratefixing times put on. As they are issued to the shops, the times are summarised, so that when the job is fully issued, a further comparison can be made.

As the job proceeds in the shops, the Ratefixing Department make weekly returns of any extra time that has to be given, together with reasons. At the same time, a return from the Progress Department gives details of the *estimated* man hours completed, so that an accurate and up-to-the-minute picture can be obtained of

the three essentials—Amount Estimated—Amount Spent—and Percentage of Work Completed.

A similar statement in respect of Test Plant Tooling and Raw Material completes the picture.

All this may sound rather cumbersome, but the fact is that in my organisation, which is of reasonable size, the system is run by two engineers and a clerk.

The information so given is invaluable, as not only can one see how the cost is going, but it also gives an admirable overall picture of the Progress position of the job as a whole.

All this does not of course *control* the cost. This can only be done by the action of responsible officials, but at least they have the requisite information on which to make their decision, and if overspending is inevitable, they know why, and the extra money can be authorised in advance and appropriate measures taken.

PLANT DRAWING OFFICE The Plant Drawing Office is a department whose functions are familiar to most of you. It is responsible for the ordering and installational instructions for all plant and machine tools, preparation of shop layouts, maintenance of all records of Plant and Machine Tools, and for the issue and record of all requisitions, after due authorisation, for expenditure against revenue.

In a Research and Development Unit, they are kept pretty busy, as the shop layout and plant requirements are constantly changing as development proceeds and new projects are started.

DESIGN VETTING AND TARGET PROGRAMMING The next function on the chart has already been described and is not in fact a separate department. The work of Design Vetting and Target Programming is so tied up with major policy that it has to be under the immediate eye of the Chief Production Engineer and is therefore done by a group of personal assistants under the immediate supervision of the Chief Production Engineer himself.

FUTURE MANUFACTURE The final function on the chart—Future Manufacture—is I think self explanatory. Obviously Research and Development is not carried on for the fun of it. Its purpose is to develop an engine which will go into production.

As this stage approaches, even if production is not to be carried out in the same works, the Research and Development Unit has considerable responsibility for initial consideration of machine tools, floor areas and tooling costs required to meet any estimated production programme and will probably be responsible for ordering special or long dated machine tools, plant and equipment.

The details of the work will be the responsibility of the purely production side, although the department will still be responsible

for liaison in respect of modifications to be introduced as a result of further development, or defects shown in service.

SUMMARY I have now dealt with the main organisational differences between Manufacturing, and Research and Development Units. Very few of the functions described are wholly peculiar to such a unit except in detail, but their emphasis is different.

It is however essential that any system shall be flexible, as any sign of rigid bureaucracy would be fatal to a Research and Development Unit.

Legitimate ways must be established to short circuit in an emergency any part of the system not absolutely necessary in the interests of speed, and certain officials must have the power to break any part of it on occasions, provided always that in so doing they take complete responsibility for seeing the job through to the end, so that other people do not have to spend an inordinate amount of time clearing up after them.

In the main I have described systems and procedures, but I would like by way of an epilogue to state one very important principle which should be written on the hearts of all Administrative and Production Engineers.

A system, however perfect, by itself does *nothing*. Work is only done by people, and the system is only there to enable them to do their work without overlap or confusion.

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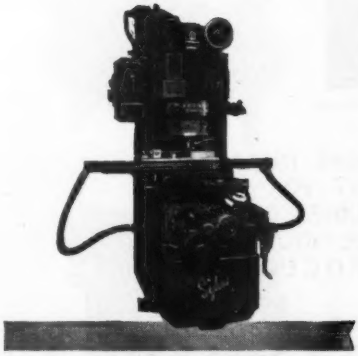

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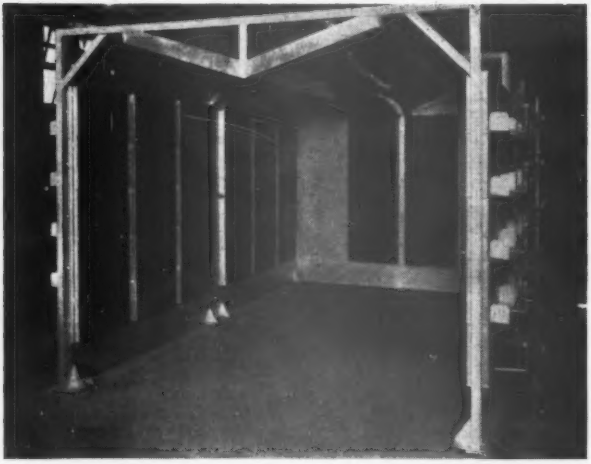

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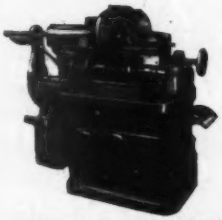
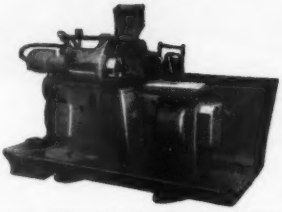


B.S.A. SINGLE & MULTI-SPINDLE AUTOMATIC BAR MACHINES.



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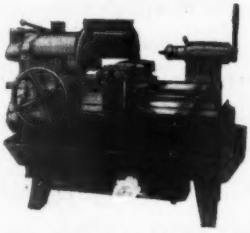

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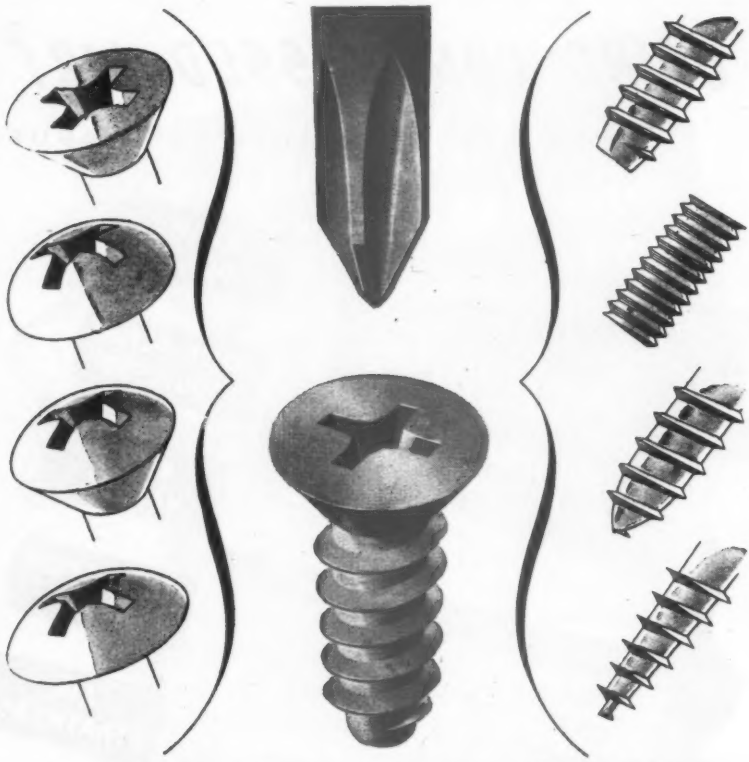

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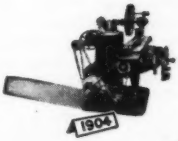
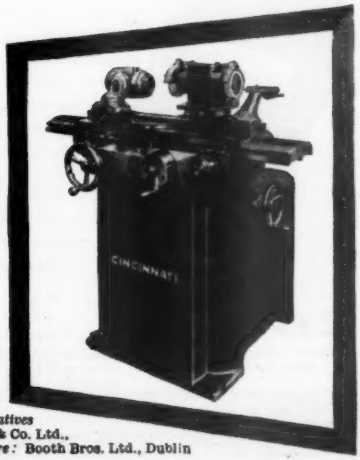


Because of their intimate association with machine tool development, Cincinnati have an unique record in cutter grinder design, too, and the modern Cincinnati Cutter and Tool Grinder brings to the skilled operator a tool of high precision and reliability.



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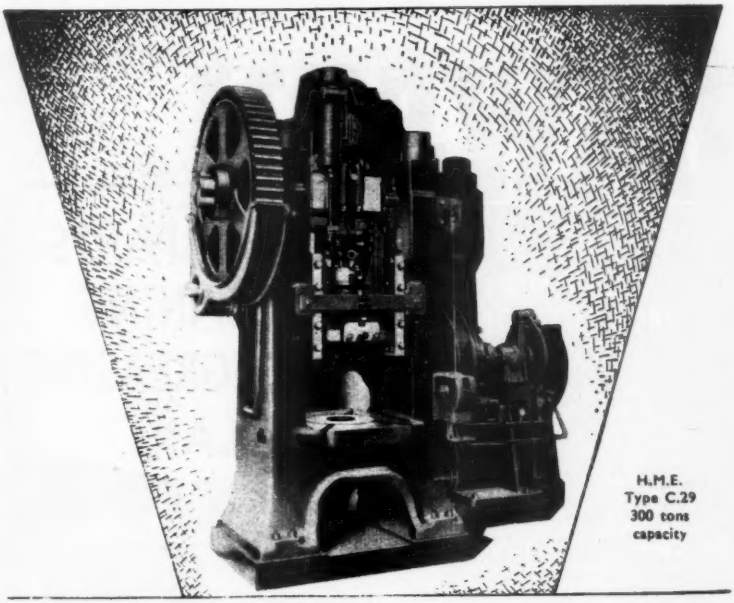

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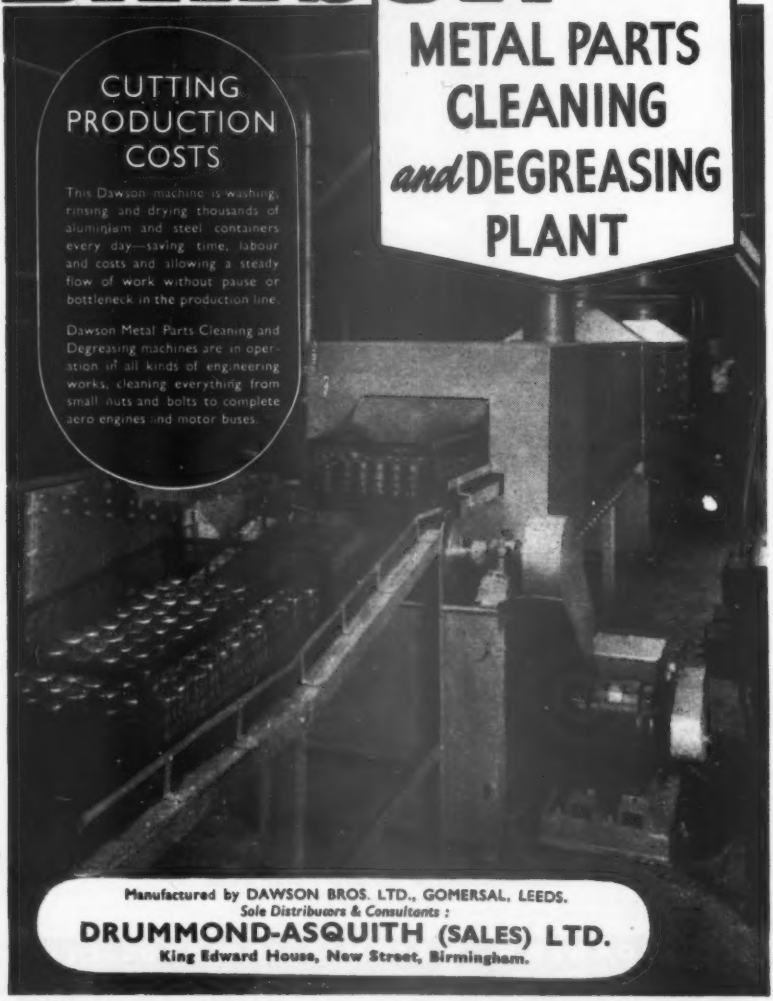

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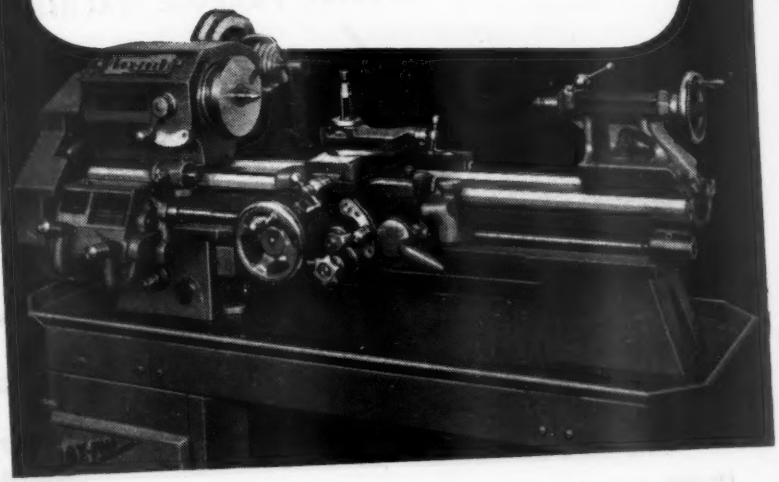

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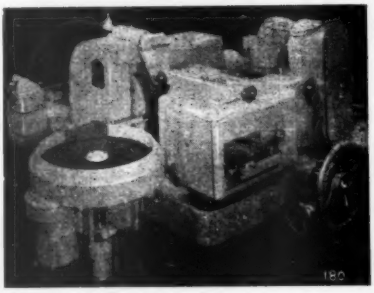
Centreless Grind!



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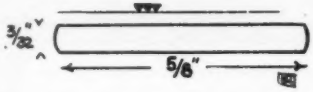

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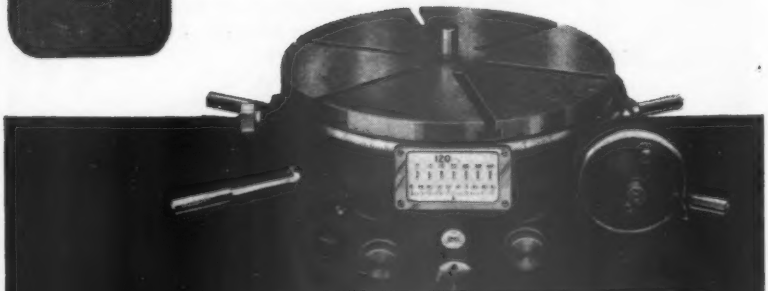

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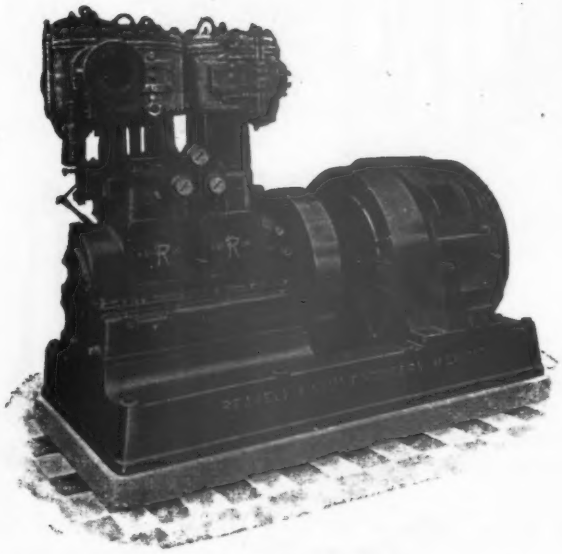

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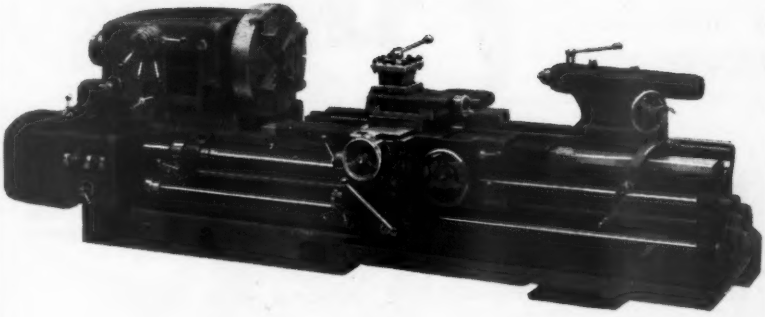

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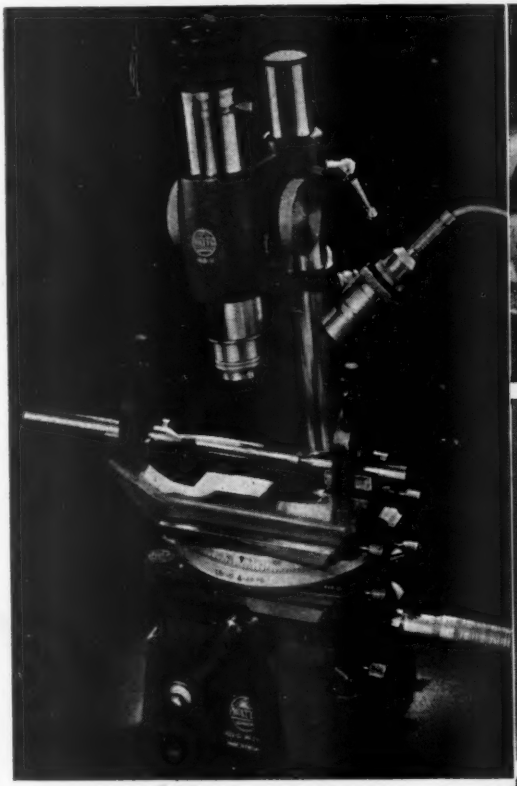

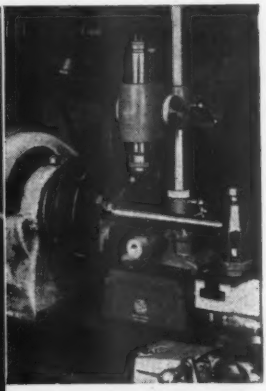

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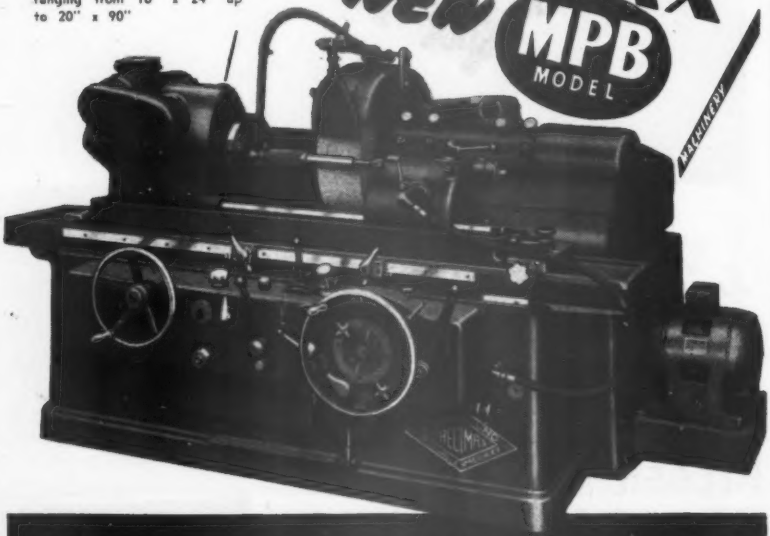

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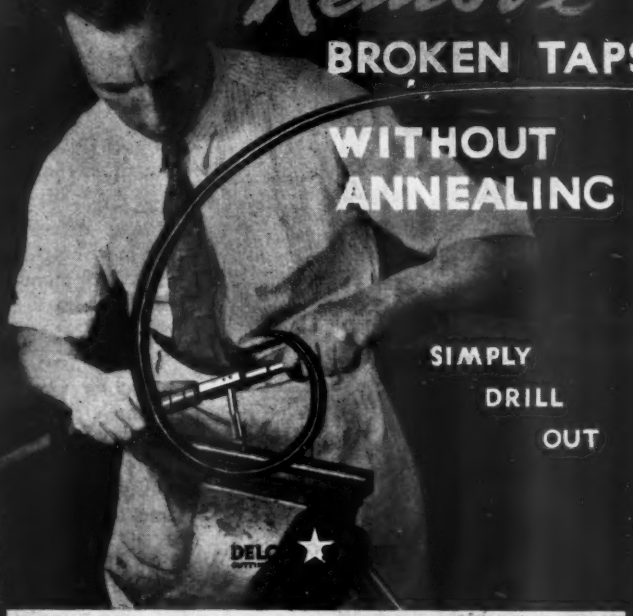

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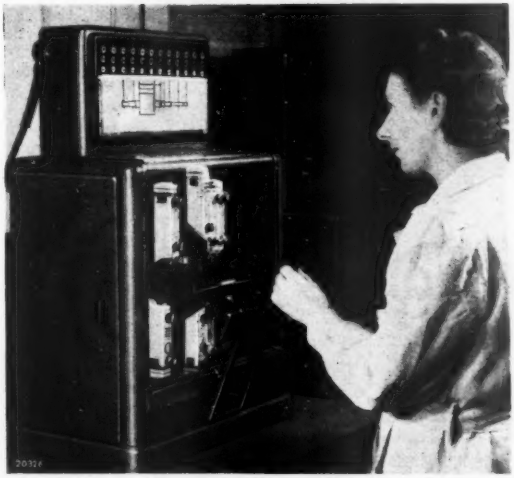

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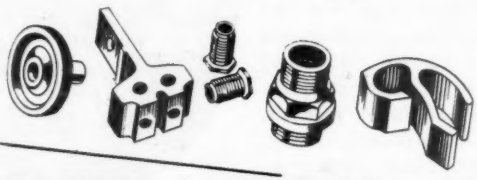

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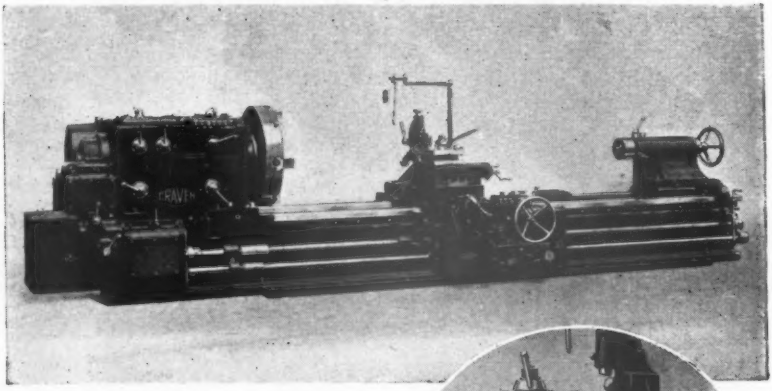

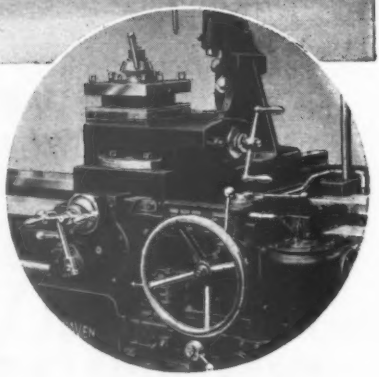

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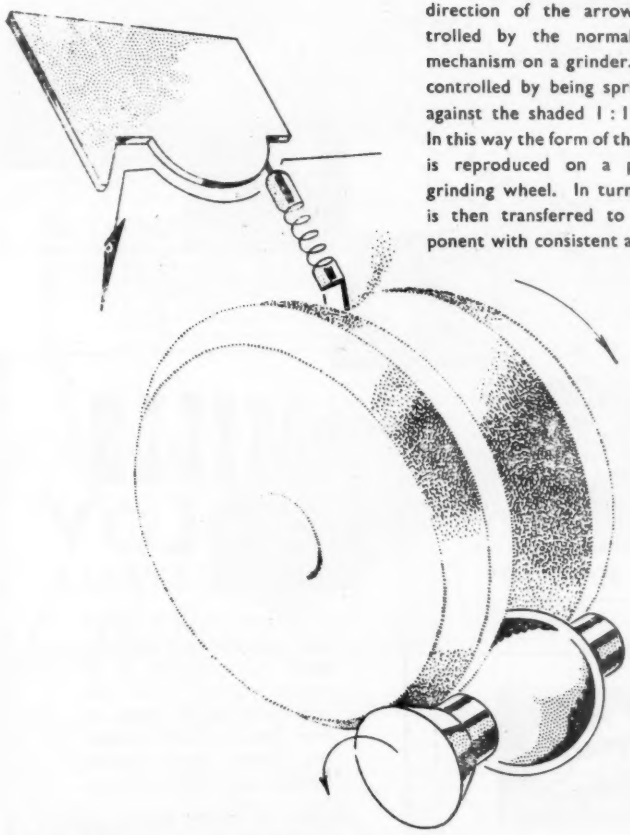

The path of the Dianyf tool in the direction of the arrows is controlled by the normal dressing mechanism on a grinder. It is also controlled by being spring loaded against the shaded 1 : 1 template. In this way the form of the template is reproduced on a production grinding wheel. In turn the form is then transferred to the component with consistent accuracy.

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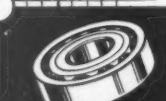

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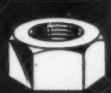

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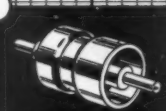

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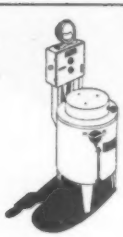

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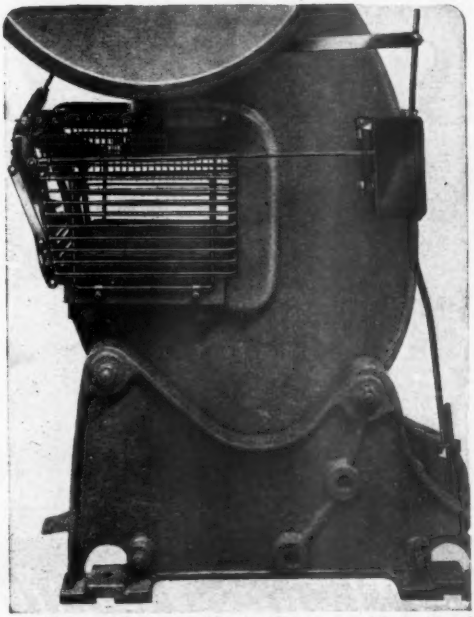

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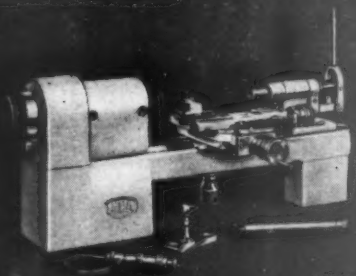

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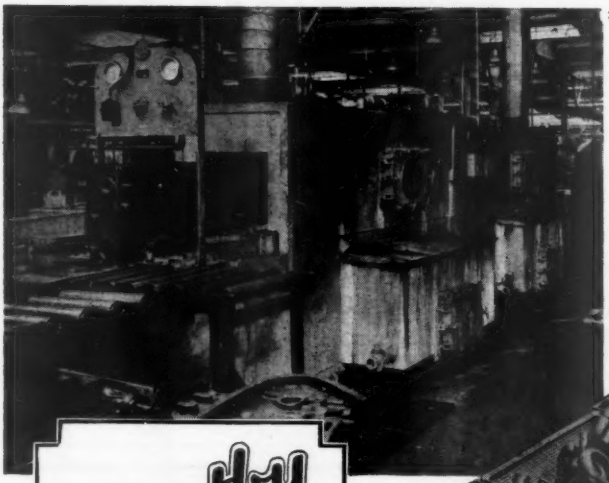

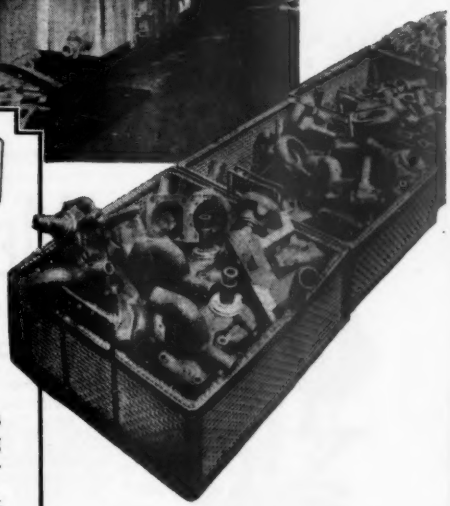

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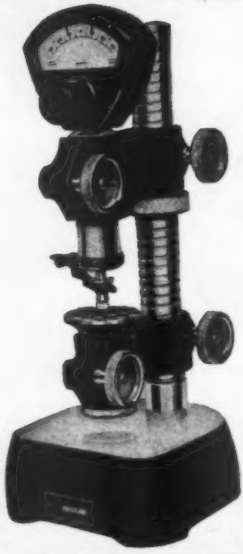

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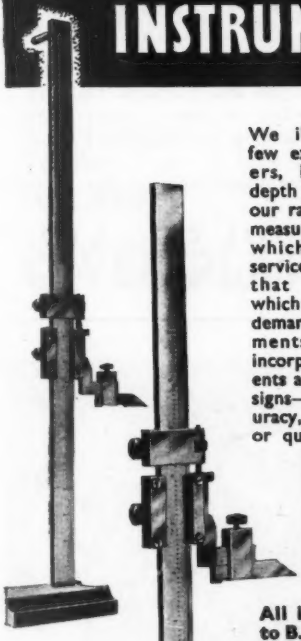

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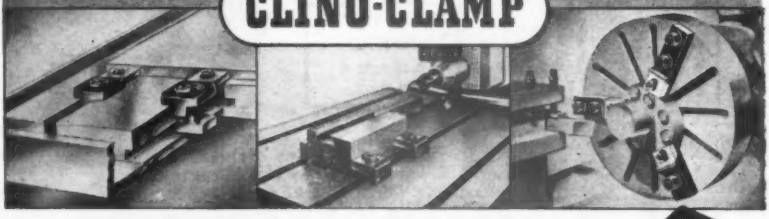

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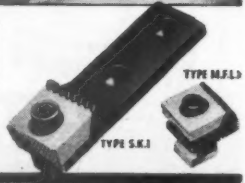

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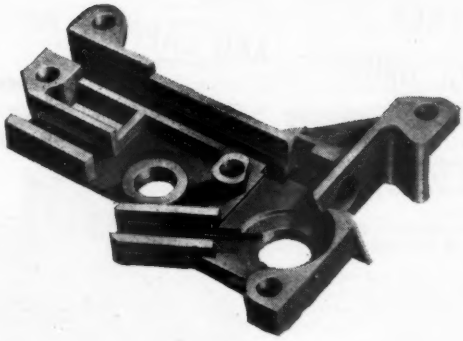

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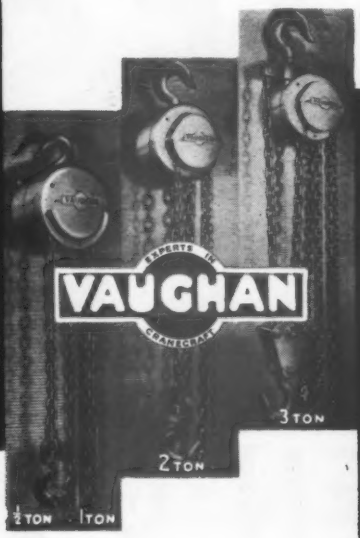

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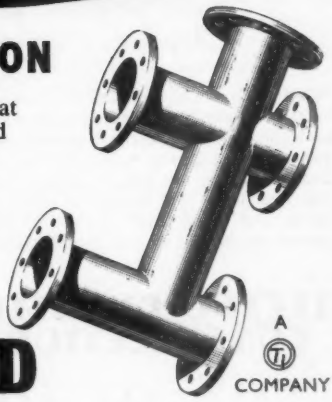

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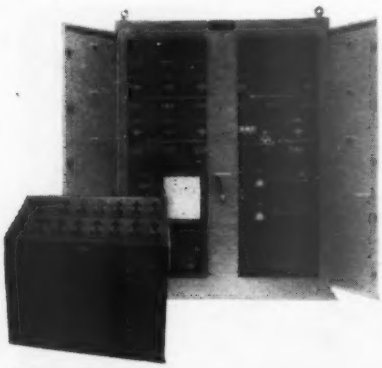

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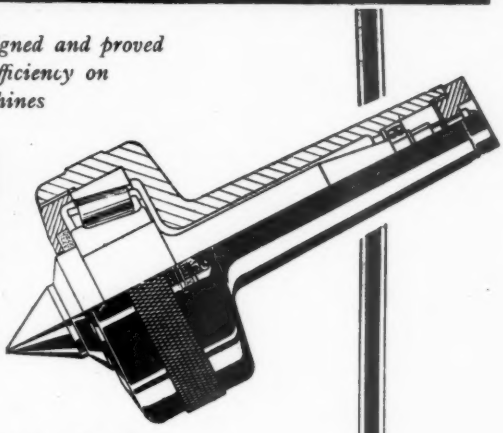

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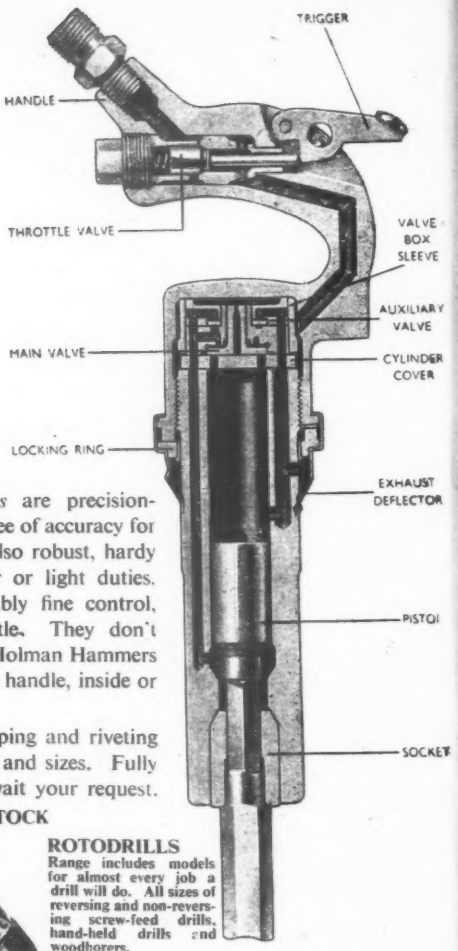

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